

# MATERHORN FogX Plan

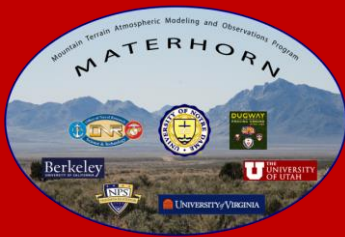
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MATERHORN Investigator Meeting – IV

October 9, 2014  
University of Utah

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# MATERHORN-X

## 1) MATERHORN-1X Fall (DPG)

- Focus: Thermally driven winds/dry
- 25 Sept - 21 Oct, 2012

## 2) MATERHORN-2X Spring (DPG)

- Focus: synoptically forced/moist
- 1 May – 31 May, 2013

## 3) MATERHORN-FogX (Salt Lake & Heber Valleys)

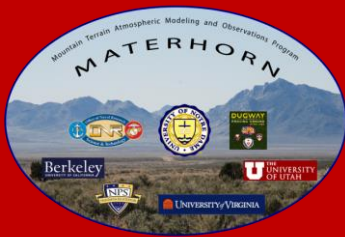
- Focus: Fog formation in complex terrain

Intro

Site

Results

Summary

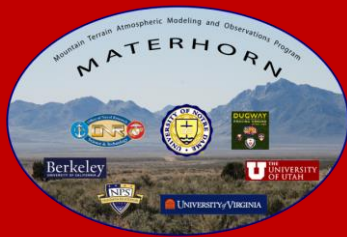


# Origins Fog Prediction in Complex Terrain

ARATUS (315–240 B.C.) - Prognostication Through Weather Signs

“ If a misty cloud be stretched along the base of a high hill, while the upper peaks shine clear, very bright will be the sky. Fair weather, too, shall thou have, when by sea-verge is seen a cloud low on the ground, never reaching a height, but penned there like a flat reef of rock”

From Gultepe et al 2007 Review, English translation by G.R. Mair (ARATUS, 1921)



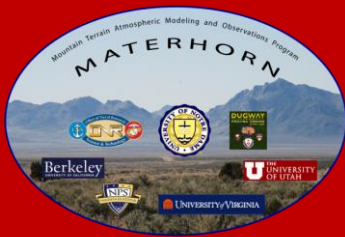
# MATERHORN FogX Participants

- University of Utah
- University of Notre Dame
- University of Virginia
- Environment Canada - Cloud Physics and Severe Weather Section
- Army Research Lab

## Contributors

- NCAR
- Dugway Proving Ground

Intro  
Site  
Results  
Summary

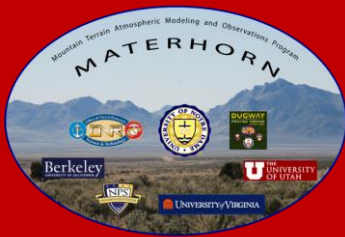


# Motivation for Studying Fog in Complex Terrain

- Limit military operations
- Ground Transportation
- Air Travel
- Relationship to air quality

General difficulty in fog forecasting due to uncertainties and complexities, Gultepe et al. 2007  
Review:

"Fog processes involve droplet microphysics, aerosol chemistry, radiation, turbulence, large/small-scale dynamics, and surface conditions (e.g., pertaining to the presence of ice, snow, liquid, plants, and various types of soil)"



# MATERHORN FogX Goals

- Improved understanding of fog formation, evolution and dissipation mechanisms in complex terrain
  - Radiative cooling, surface moisture, aerosol size distribution, snow cover, turbulent intensity and turbulent flux divergences
- Produce a unique dataset to evaluate how improved/new turbulence parameterizations being achieved through MATERHORN will impact fog predictions and forecasting



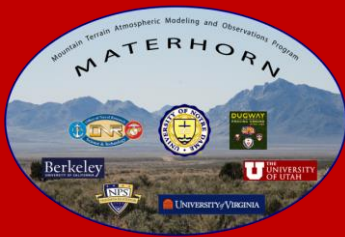


# FogX Timeline

## October 2014 through March 2015

- October/November 2014 – Main instrument deployments
- October 2014-March 2015 – Continuous measurements
- November 2014 and January 2015 – Intensive Observational Periods (IOPs)

IOPs	Type	Dates	No. of IOPs
IOP Block 1	No Snow	9-24 November 2014	2-3
IOP Block 2	Snow on Ground	5-20 January 2015	2-3
Flexible		25 Nov to 4 Jan	4-6



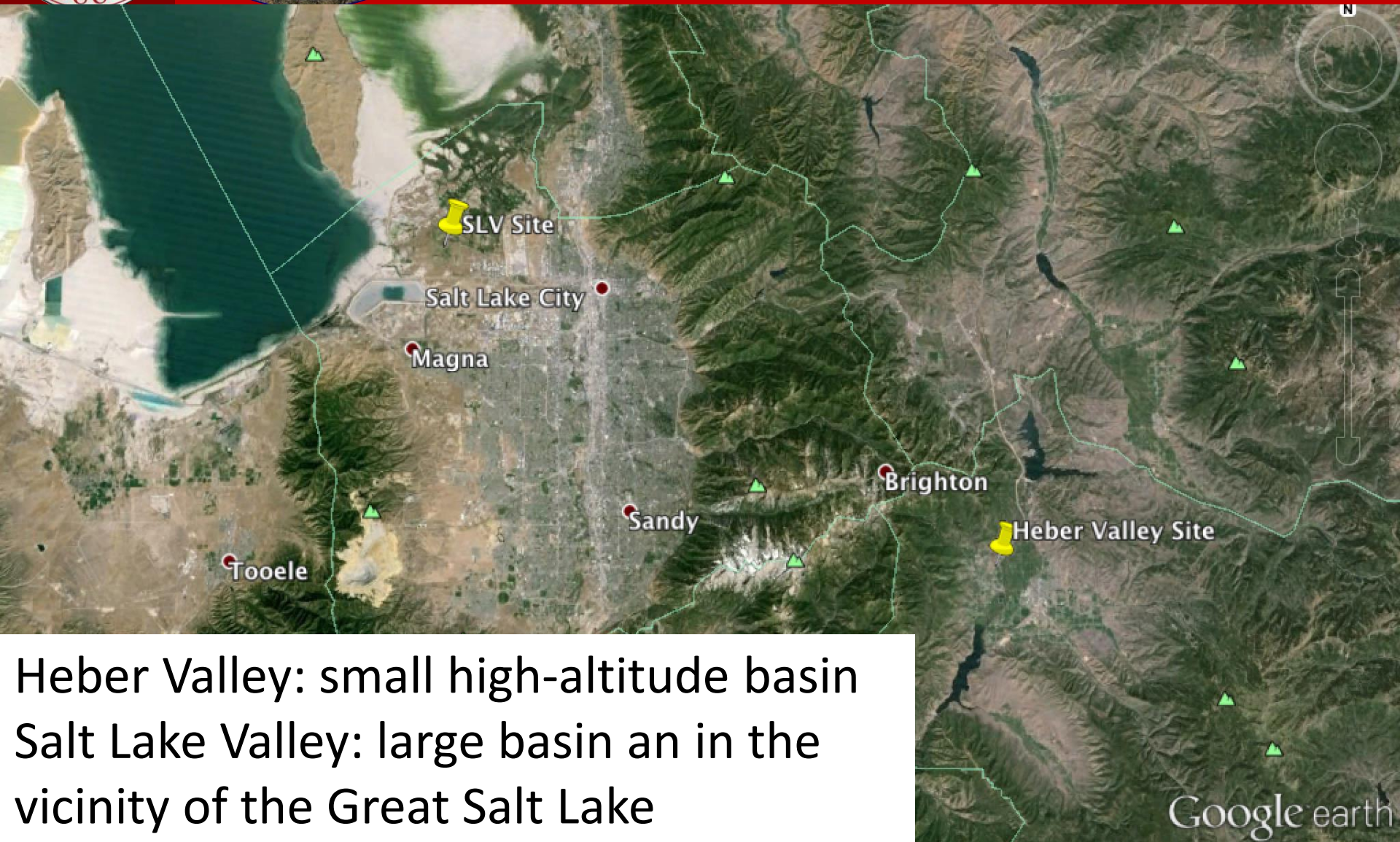
# FogX Planned Operations

- Daily Forecasts during the IOP period from NWS (Larry Dunn and Randy) and the University of Utah (Jeglum and Pu) will guide operations
- IOPs will be focused around forecasted IOP events
- Duration will be no more than 24 hours depending on the fog type (persistent versus short live diurnal fogs)

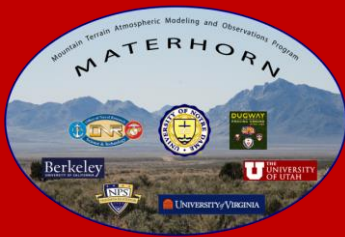




# Planned Experimental Sites

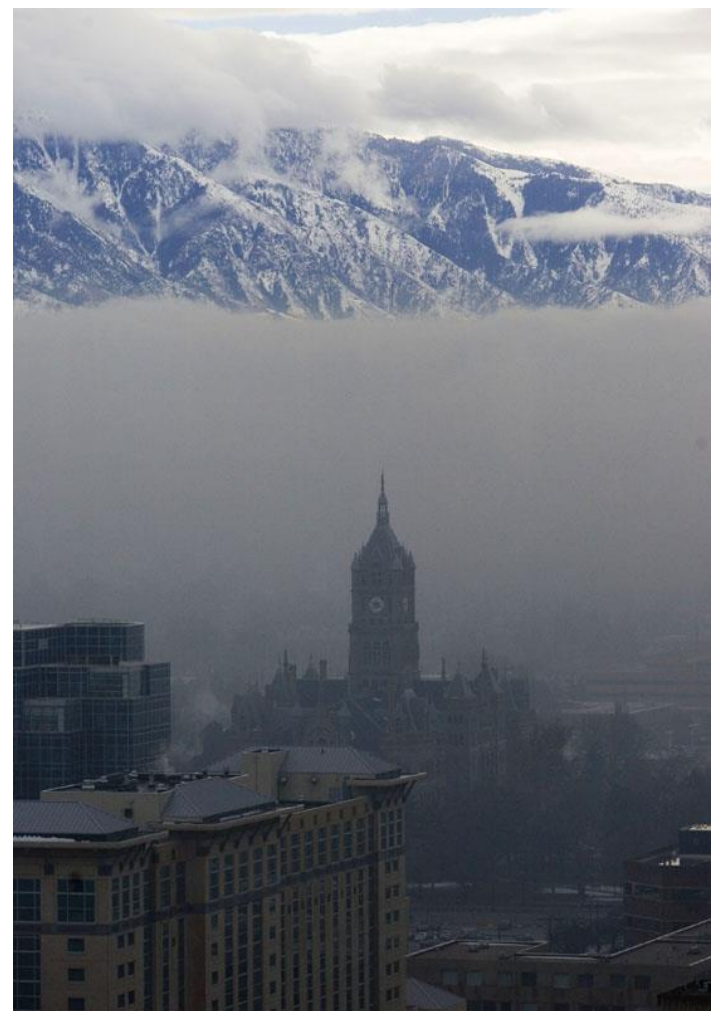


Heber Valley: small high-altitude basin  
Salt Lake Valley: large basin an in the vicinity of the Great Salt Lake



# Salt Lake Valley

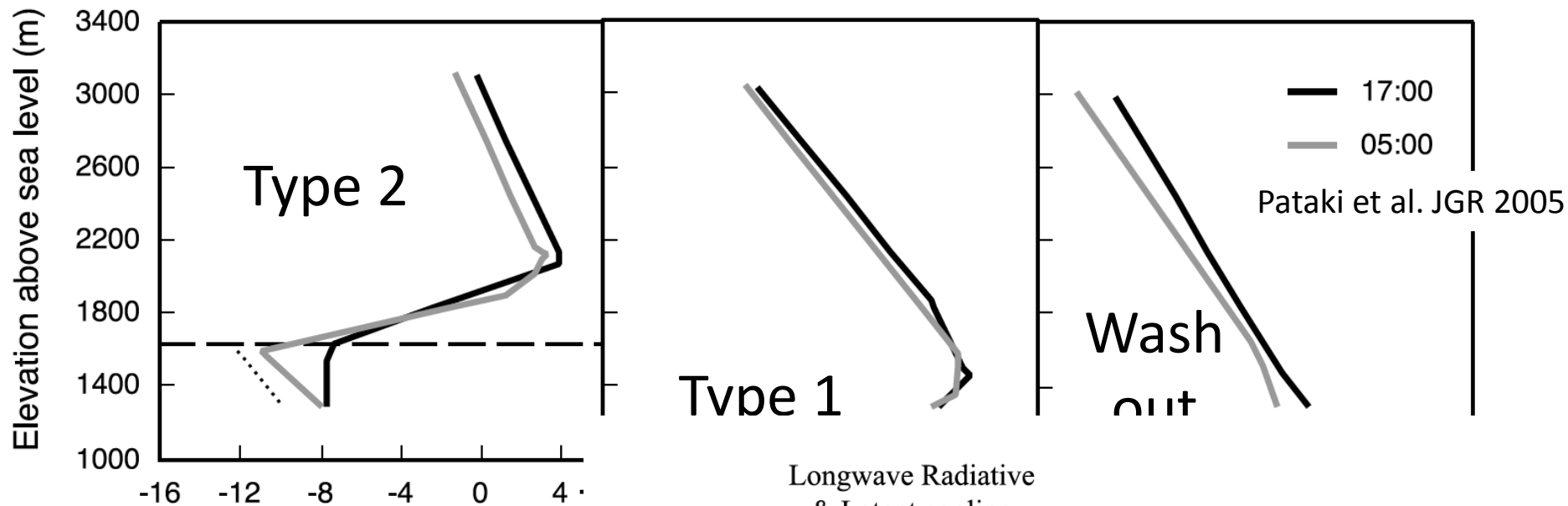
- Urbanized
- Mostly wintertime inversion related fog
- Potential for lake related advection fog
- Snow on the ground
- Persistent Cold Air Polls
- Moisture build-up
- Associated with limited visibility & poor air quality



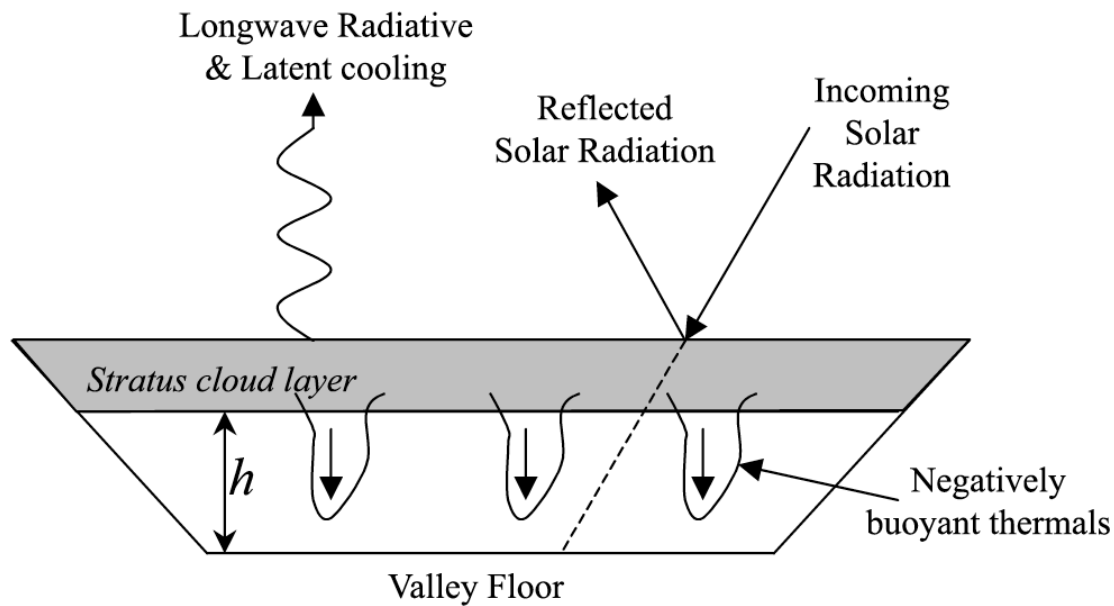


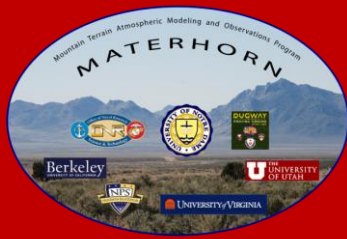


# Salt Lake Valley

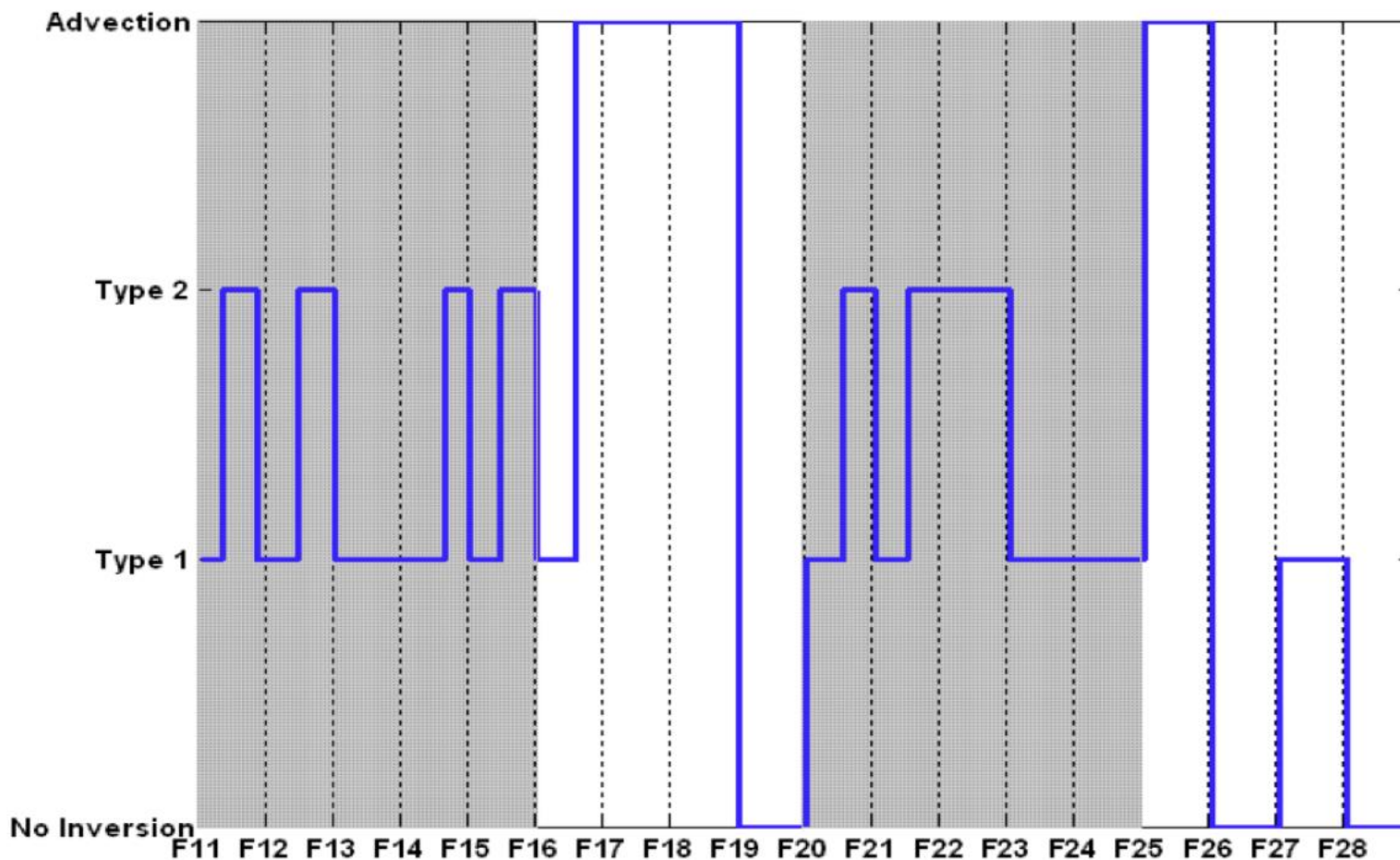


2/21/04 (Cold Air Pool)

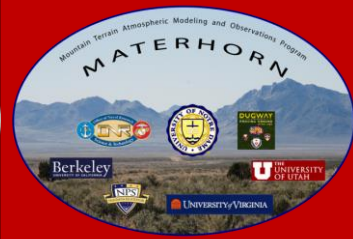




# Salt Lake Valley



What processes lead from stratified to well-mixed fog during inversions?

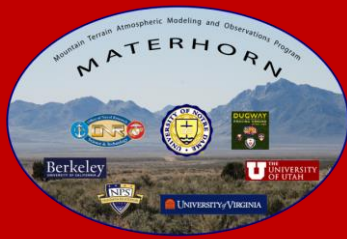


# Heber Valley Site

- Less urban valley with agriculture
- Radiation Fog
- Post rain non-snow fog events (Dunn/Graham)
- Persistent Cold Air Pools
- Fog with snow on the ground
- More diurnal fog







# Heber Non-Snow Fog

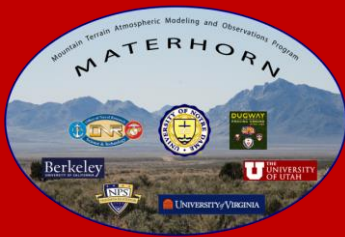
Hay stacked up in squares with fog, Heber valley, Utah, agricultural



From: <https://www.holdman.com>

© Willie Holdman





# Heber Non-Snow Fog



Lynne Fawcett Fishman  
October 14, 2012

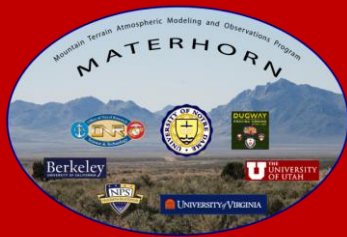


# Heber Non-Snow Fog



September 11, 2010



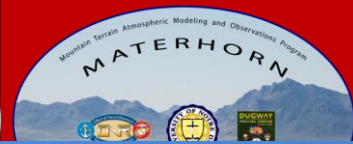


# Salt Lake City Site

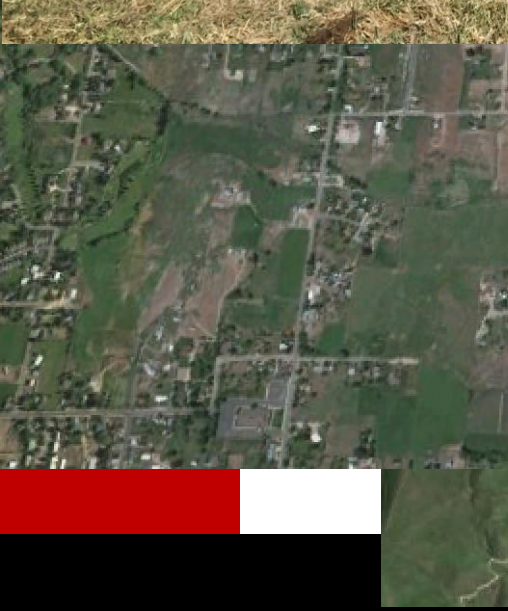
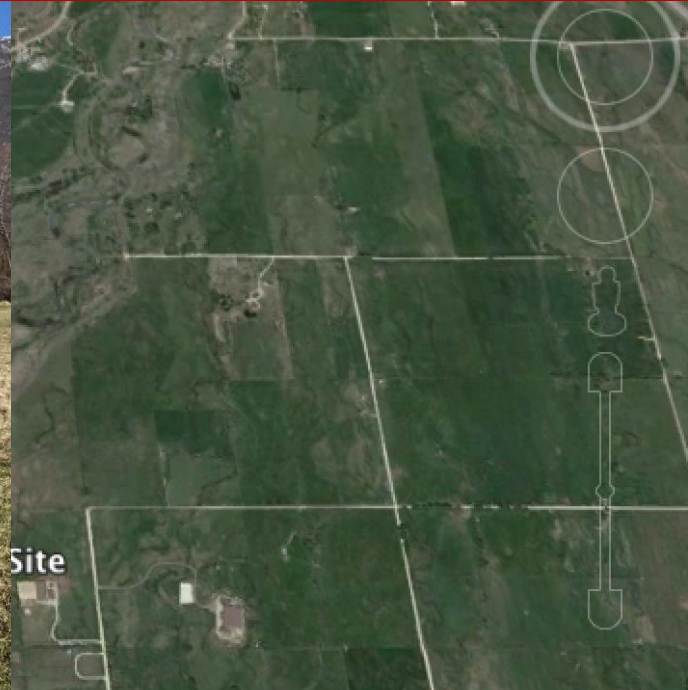
- Owned by Kennecott Utah Copper LLC
- Agricultural Land with primarily short grasses
- Close to both the Great Salt Lake and the SLC International Airport



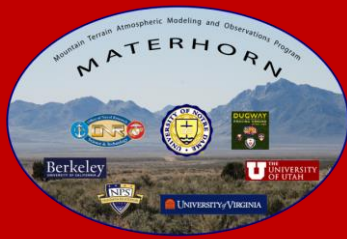




# Heber Site







# Experiment Details

## 1. Turbulence Tower Based Measurements

- Turbulence towers
- Detailed Radiation Balance
- Flux divergences (sensible, latent, radiative)
- Surface Energy Balance

## 2. Meteorological Stations

- 14 LEM stations
- Gultepe station
- Existing mesonet

## 3. Ground-Based Remote Sensing

- Wind LIDAR (UU)
- Aerosol LIDAR (UVA)
- SODAR/RASS (UU)
- Ceilometers

- Tethered Balloon soundings – Heber Valley only

## 5. Fog Sensing Equipment

- Present weather station (Visibility, fog, rain)
- LPM Rain spectra (droplet size)
- FMD fog droplet spectra sensor (<50 micron, 15 channels)

## 6. Particulate

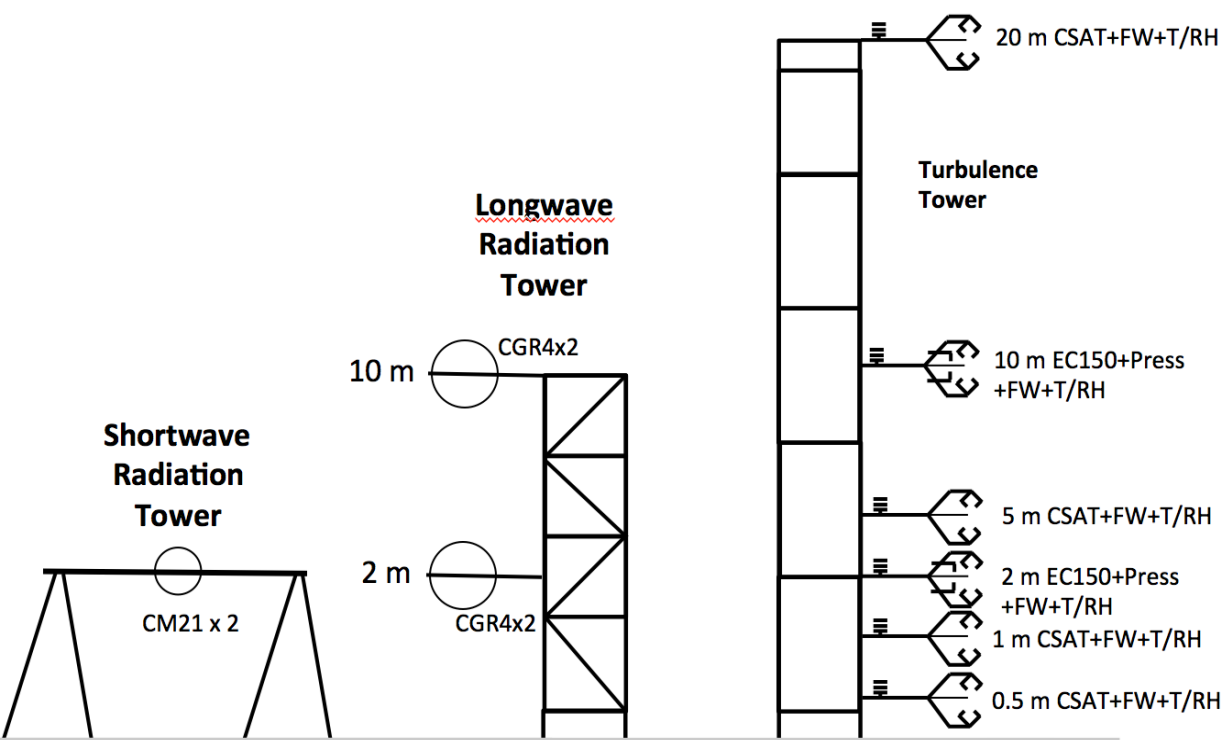
- Size segregated particle counter
- Nephelometers

## 7. Other

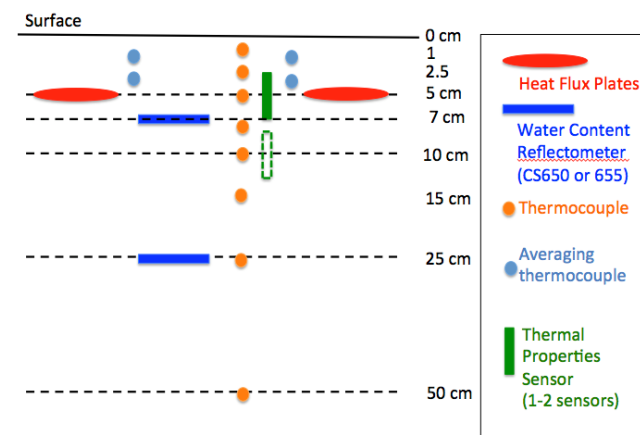
- IR surface temperature measurements
- Soil moisture sampling
- Snow depth



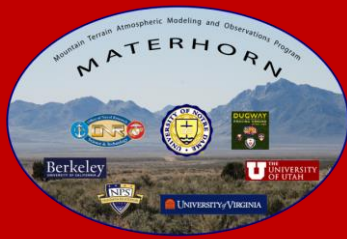
# Basic Site Towers: Experiment Details



## Subsurface





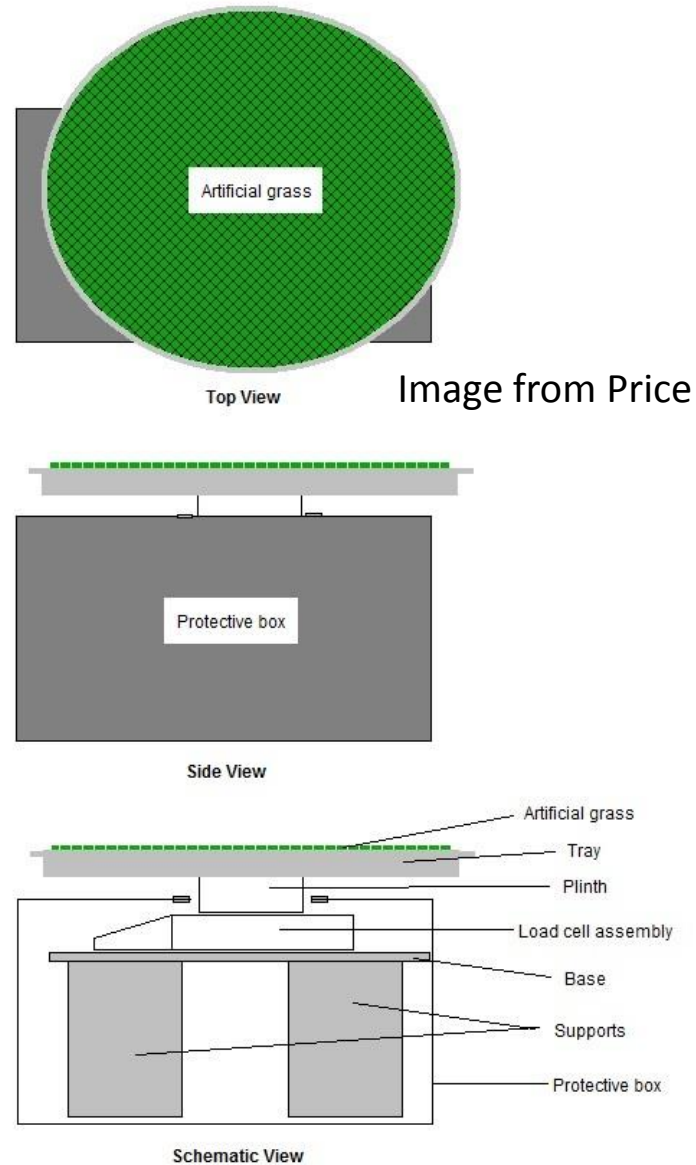


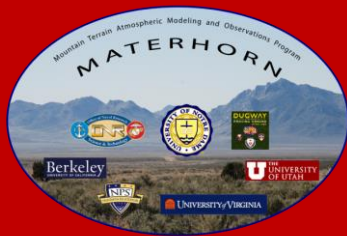
# Whiteman Fog Deposition Experiments

1. Fog net - Ionic analysis of the water during strong wintertime inversions
2. Dewfall and fog-droplet deposition measurement – load cell design based on Price and Clark, BLM, 2014



Image from Price and Clark, 2014





# Continued MATERHORN FogX

- Current Operational Plan on Evernote
- IOP forecasts and Daily Planning Meeting Notes will again be maintained on Evernote
- Tomorrow morning discussion and planning session
- Field visit to Heber tomorrow afternoon